DOCUMENT RESUME

ED 463 298 TM 033 725

AUTHOR Munby, Hugh; Versnel, Joan; Hutchinson, Nancy L.; Chin, Peter; Berg, Derek H.

TITLE Workplace Learning and the Metacognitive Functions of Routines.

PUB DATE 2002-04-00

NOTE 17p.; Paper presented at the Annual Meeting of the American Educational Research Association (New Orleans, LA, April 1-5, 2002). "From the program of research, Co-operative Education and Workplace Learning (Hugh Munby, Nancy L. Hutchinson, Peter Chin, Investigators) funded by the Social Sciences and Humanities Resource Council of Canada."

PUB TYPE Reports - Evaluative (142) -- Speeches/Meeting Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.

DESCRIPTORS Cooperative Learning; *Learning; Learning Theories; *Metacognition

IDENTIFIERS *Daily Routines; *Workplace Learning

ABSTRACT

This paper makes the case that a theory of how one learns in the workplace is incomplete without attention to the metacognitive functions of routines. Results of a program of research on cooperative education and work-based learning suggest that working knowledge is qualitatively different from the knowledge of school, being action knowledge, and more procedural. The paper reviews the research literature relevant to workplace knowledge and learning, metacognition, and routines. Data from research projects focusing on routines are also reviewed. The first studies were detailed ethnographic studies of high school students in co-op education workplace settings, and the second set of studies included observations and interviews in widely differing work settings. These studies were the foundation of the instructional theory of the metacognitive functions of routines. The paper concludes by showing how an instructional theory based on the metacognitive functions of routines is consistent with current research on workplace knowledge and learning. (Contains 75 references.) (SLD)

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HUGH MUNBY
JOAN VERSNEL
NANCY L. HUTCHINSON
PETER CHIN
DEREK H. BERG

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WORKPLACE LEARNING AND THE METACOGNITIVE FUNCTIONS OF ROUTINES[1]

Hugh Munby, Joan Versnel, Nancy L. Hutchinson, Peter Chin, and Derek H. Berg

Faculty of Education
Queen's University
Kingston, Ontario K7L 3N6

Introduction

This paper argues that a theory of how one learns in the workplace is incomplete without attention to the metacognitive functions of routines. Research of the past few decades has shown that metacognition is critical to the development and use of strategies by inefficient learners (e.g., novices, students with learning disabilities). These learners benefit from having others make implicit processing explicit to them (Davidson & Sternberg, 1998). Descriptive studies of communities of practice and the socialization of novice and inefficient workers (e.g., Wenger, 1998) illustrate the role of interaction in workplace learning. What is not clear in these accounts is how these interactions foster knowledge in action and what may be missing when these interactions are unsuccessful. Many have suggested that there are generalizable workplace skills that can prepare high school students for workplace entry (Conference Board of Canada, 1992; Secretary's Committee on Achieving Necessary Skills, 1991, cited in Wraga 1998). However, our research suggests that such skills do not directly foster workplace learning. They appear to be too discrete, inert, and school-like.

In our program of research on co-operative education and work-based learning we have argued that working knowledge (the action knowledge used in the workplace) is qualitatively different from the knowledge of school: school knowledge tends to be propositional (declarative) while workplace knowledge tends to be action knowledge (procedural knowledge). Indeed, propositional knowledge in the workplace is always directed ultimately at action, but this is not necessarily the case in school. Also, the curriculum of the workplace is organized differently: unlike the sequential nature of the school curriculum, the organization of workplace learning is centered on clusters of tasks that tend to be introduced early in the work placement (Munby, Chin, Hutchinson, in press; Steiner Bell, Chin, Munby, & Hutchinson, 2001).

Our studies of students in the workplace suggest that these clusters of tasks can be understood as routines (Pentland, 1995). We developed this unit of analysis, the routine, from two sets of empirical studies. The first set is of detailed ethnographic case studies of high school students in co-op education workplace settings (e.g., dental office, veterinary hospital) (e.g., Chin, Munby, & Hutchinson, 2000). The second set of studies include observations and interviews with employers and employees in widely differing work settings (retail outlets, service industries, opticians) (Versnel & Munby, 2001). All these studies show that routines are central to work and that they "sit," as it were, metacognitively upon action knowledge. In this paper, we argue that teaching about the character of routines can serve as metacognitive instruction for novices in work sites. The theory is grounded on two assumptions: (a) that work can be conceptualized as routines, and (b) that the concept of routines can be taught.

The paper begins by reviewing the research literature relevant to workplace knowledge and learning. It moves to the literature on metacognition and thence to the literature on routines. Then we describe data from our workplace research. These sections provide the foundation for our instructional theory of the metacognitive functions of

[1]Presented at the annual meeting of the American Educational Research Association, New Orleans, April 2002. The paper is from the program of research, Co-operative Education and Workplace Learning (Hugh Munby, Nancy L. Hutchinson, Peter Chin, Investigators) funded by the Social Sciences and Humanities Research Council of Canada. The research of Co-op Education and Workplace Learning research team is described at http://educ.queensu.ca/~cewl/. For further information, please contact munbyh@educ.queensu.ca

routines. Finally, we show how an instructional theory based on the metacognitive functions of routines is consistent with current research on workplace knowledge and learning.

Learning in the Workplace

In this section, we review research that has contributed to our understandings about the character of workplace knowledge and how it is acquired. The review begins with skills, and then moves to knowledge before considering learning and instruction.

Skills for the Workplace

Because our research is aimed at enabling students to learn in the workplace, our review of workplace knowledge and workplace learning begins with approaches that have been driven by similar goals. A prominent approach among these focuses upon skills. In the last decade, countries like the United States, Canada, Australia, and Great Britain were home to several government and business initiatives aimed at defining the basic work-related skills and competencies that individuals required to prosper in the modern workplace. For instance, the Secretary's Commission for Achieving Necessary Skills (SCANS) in the U.S. was mandated in 1991 to identify the workplace skills needed by young people (Resnick & Wirt, 1996). SCANS identified a three-part foundation of skills and personal qualities and five workplace competencies needed for successful performance in the workplace. The foundation skills include: basic skills such as reading, writing, arithmetic, speaking, and listening; thinking skills such as the ability to learn, to reason, to think creatively, to make decisions, and to solve problems; and personal qualities such as responsibility, sociability, self-management, and integrity. The workplace competencies included the ability to use: resources, interpersonal skills, information, systems, and technology (SCANS, 2001, http://wdr.doleta.gov/SCANS/idsrw/).

Human Resources Development Canada identified a set of essential skills very similar to those compiled by SCANS (Human Resources Development Canada, 1994, http://www15.hrdc-drhc.gc.ca/english/introasp). These were used to develop Occupational Profiles for 150 occupations in Canadian industry. Also, the Conference Board of Canada (1992) launched the Employability Skills Forum to conduct research, and to produce tools and strategies for assessing, developing, and enhancing the employability skills of Canada's current and potential workforce. The Forum published the first employability skills list in 1996. This was revised in May 2000 and released as Employability Skills 2000+ (Conference Board of Canada, 2000, http://www.conferenceboard.ca/education/learning-tools/esp2000).

Employability Skills 2000+ lists critical skills needed in the workplace, and organizes them into three major categories: fundamental, personal management, and teamwork skills. Fundamental skills include those that are needed as a basis for further development such as: communication, managing information, using numbers, and thinking and solving problems. Personal management skills are identified as the skills, attitudes, and behaviours that provide an individual's potential for development and growth. These skills include demonstrating positive attitude and behaviour, being responsible, being flexible and adaptable, continuous learning, and working safely. Teamwork skills are needed to contribute productively and include the ability to work with others and to participate in projects and tasks.

Of course, it is one thing to compile lists of employability and essential skills, and quite another to conduct the research needed to determine if these skills are the actual competencies sought by employers and used in the workplace. Stasz (1997) has attempted to enhance the understanding of how skills are constituted in the workplace so that curricular reform in schools can be more effective in preparing young people for the world of work. Stasz and her colleagues (Stasz, McArthur, Lewis, & Ramsey, 1990; Stasz, Ramsey Eden, DaVanzo, Farris & Lewis, 1993) conducted a study of workplace skills in four firms in Los Angeles county. Observations of the workers functioning in the workplace and interviews with the employees were conducted. Senior managers were also interviewed to obtain information about each company's perceived skill needs and policies regarding acquiring and/or developing workforce skills. Documents such as job descriptions, training plans, and salary schedules were

also collected and examined. Data were analyzed according to the competencies identified by SCANS. The study confirmed that employers accurately described the skills employees required for success in the workplace, but the study also showed that many of these needed skills were highly context-dependent (Stasz, 1997). So it is reasonable to question the general applicability of essential or employability skills to workplace learning and instruction.

Workplace Knowledge

Knowledge enacted in the workplace tends to be tacit or opaque (Billett, 1995). Sternberg and his colleagues have been investigating tacit knowledge for many years (Sternberg, 1998; 1999; Sternberg, et al., 2000; Wagner & Sternberg, 1985; 1999; Williams, Sternberg, Rashotte & Wagner, 1993). For them, tacit knowledge is procedural knowledge that guides behaviour but is not readily available for examination (Sternberg, 1999). Tacit knowledge is largely acquired from experience, and the ability to decode tacit knowledge is the determining factor, rather than the experience itself (Davidson, Deuser, & Sternberg, 1994). Tacit knowledge can usually be acquired more readily in situations that are unusual because experts will use more metacognition to make tacit knowledge more explicit (Sternberg, 1999). Davidson and Sternberg (1998) stated "declarative and procedural metacognitive knowledge about problems helped problem solvers to strategically encode and mentally represent the critical givens in a problem" (p. 64). The problem solver can use metacognitive planning and can select strategies to decide where to begin the problem solving process, to anticipate the obstacles, and to form outcome expectations. Metacognitive knowledge about problems in the workplace, about potential solutions, and about evaluating outcomes is part of the expert's repertoire. The novice needs to be able to access this metacognitive knowledge to develop expertise.

An alternative approach to conceptualizing workplace knowledge flows from constructivism. A constructivist view of learning holds that individuals construct knowledge of their experiences. As a Vygotskian perspective, this view of cognitive development emphasizes guidance by social and cultural circumstances (Martin & Scribner, 1991). This guidance can be proximal, provided by a mentor/expert or it can be distal, provided by social norms, practice, or the physical setting where it occurs (Scribner, 1985). These social circumstances where individuals interact are known as communities of practice (Lave & Wenger, 1991). Within this constructivist perspective, individuals appropriate knowledge and make it meaningful for themselves (Hung, 1999; Rogoff, 1990). As the person spends more time in the community of practice, the representations which formed the basis of appropriation of knowledge acquire greater congruity with the representations of others in the community of practice (Lave & Wenger, 1991). The constructivists argue that all forms of knowledge with the exception of higher-order procedures, or metacognition, can be acquired through participation in the community of practice (Lave & Wenger, 1991). The workplace would be the likely context to access and to appropriate workplace knowledge through active participation in the work setting.

The Character of Workplace Learning

Our approach to understanding workplace learning is cognitive and is built on the view that the efficacy of a learning arrangement can be determined by its ability to offer the learner access to the knowledge that forms the basis for the complex activity. Anderson (1982) described propositional knowledge (facts, concepts, information and assertions) as well as procedural knowledge (techniques, skills and abilities). Together these forms of knowledge are called cognitive structures. The depth of conceptual knowledge and goal-attaining procedures within a domain of knowledge are characteristics of experts. Dispositions (values, attitudes and preferences) determine the method an individual employs to construct knowledge (Prawat, 1989).

Higher order procedures monitor and organize activities, and are strategic in their application. Higher order procedures are particularly important when individuals are faced with novel activities such as complicated problem solving or transfer of knowledge to new situations (Anderson, 1982). These three forms of knowledge—propositional, procedural, and dispositional—are highly interdependent. Together these forms of knowledge constitute workplace knowledge or vocational expertise, and the ultimate goal of workplace learning is to develop the novice's abilities to the level of the expert (Billett, 2001).

Workplace studies (Billett, 1992; 1994; Darrah 1995; Martin & Scribner, 1991; Scribner, 1988; Velde & Cooper, 2000) confirmed that workplace participants accessed procedural and propositional forms of knowledge as well as dispositional knowledge conducive to vocational practice. This knowledge is secured through learning experiences that are authentic and guided. Everyday participation gives novices multiple opportunities to develop and attempt solutions to problems. The expert others may guide by demonstrating tentative solutions, by selecting tasks, by providing means to achieve task goals, by providing opportunities to practice, and by suggesting progressively more challenging tasks—forms of guidance known as modelling, coaching, and scaffolding proposed by Collins, Brown and Newman (1989) in their work on cognitive apprenticeship.

Concerns have been raised for the exclusive use of a situated approach to workplace learning. Prawat (1989) argued that situated learning favours procedural over propositional knowledge. Berryman (1993) questioned the efficacy of a situated approach to assist a novice in understanding the tacit nature of workplace knowledge, particularly in view of the current trends toward complexity in the workplace. Constructivists would argue that the active and learner-focused nature of engagement in the workplace presses novices into a mode of knowledge acquisition which accesses higher orders of procedural knowledge and deeper conceptual knowledge (Stevenson, 1994). The appropriation of deep conceptual knowledge may require instructional intervention particularly when the knowledge is opaque (Billett, 1995). Billett stated that specific guidance is likely to be required to develop deep conceptual understanding of knowledge that is opaque and hidden from novices. As workplaces become more complex and inundated with technology, more of the workplace knowledge becomes inaccessible.

Billett (2001) suggested that guidance for learning in the workplace can be conceptualized on three levels: (a) organizing and managing learners' experience in the workplace; (b) close guidance in the development of procedures and understanding associated with work practice; and (c) the development of self-regulated learning and the transfer of working knowledge to new tasks and other workplaces. It is the second and third levels of guidance that Billett proposed as a means to engage the novice in collaborative problem solving. Through the use of modeling, coaching, scaffolding, and fading, expert guides (or mentors) assist novices to gain proficiency in tasks. Included here are strategies that provide access to opaque knowledge. The third level of guidance relates to the strategies that assist the novice to transfer knowledge and to be self-regulating, self-monitoring, and evaluative of their work accomplishments (Billett, 2001). It is at this level that the novice can repeatedly engage the mentor in the joint construction of knowledge by clarifying questions, by identifying gaps in understanding, and by seeking advice.

Billett's proposed interventions of questioning dialogues, diagrams, and analogies have not been thoroughly investigated although they have undergone trial implementation in a study involving five workplaces (Billett, McCann, & Scott, 1998). Evidence of the strategies' effectiveness was collected using a critical incident technique and interviews of both expert guides and novices. The utility of the strategies differed according to the workplace. Expert guides at companies with active workplace learning programs found the strategies lacked sophistication. At other companies, the appointed mentors had difficulty with the complexity of the strategies and making time for their use. Billett and Boud (2001) implemented the three level model during a year-long study of workplace learning in a large processing plant. This study attempted to identify the potential for guided workplace learning to overcome some of the limitations of learning through the everyday activities alone.

Summary of Literature on Workplace Learning

The research reviewed here suggests that useful conceptualizations of workplace knowledge and successful approaches to workplace learning both build on recognizing the contextual nature of work. Also, as noted in the above review of skills, it seems that the quest for generalizable essential skills may not be fruitful for informing workplace instruction. This situation is problematic for school programs like school-to-work and co-op education. On the one hand, the in-school components of these programs provide an obvious opportunity to prepare students for the workplace; yet the uniqueness of workplaces and the weaknesses of generalizable skills suggest that classroom attempts at workplace preparation are doomed. On the other hand, it is not clear that workplace supervisors would welcome the need to provide expert mentoring for every high school student so that, after Billett and Boud (2001), guided strategies would become embedded in everyday workplace activities.

Our view is that we need to explore more deeply what could be generalizable about work and workplace knowledge and learning. To begin, we suggest that it is useful to view work in terms of routines. The cognitive advantage of this, as we intend to show, is that routines themselves offer opportunities for metacognition. To be brief, the argument is that by teaching the concept of routines one can engage students with metacognitive strategies that can enhance workplace learning. In the next section, the idea of metacognition and its relationship to learning is revisited. This is followed by a section describing some of what is understood about routines and by illustrations drawn from our empirical studies of work. Then we describe what we have come to recognize as the "metacognitive function of routines."

Metacognition and Classroom Learning

As we show below, research suggests that instructional intervention based upon metacognitive principles enhances learning outcomes and academic performance in students. Most research, empirical and theoretical, on metacognitive instruction has been directed toward examining school-based learning. However, if the workplace is conceptualized as a learning environment, it may be possible to examine the extent to which metacognitive instruction enhances workplace learning and improves the employment outcomes of students in workplace settings.

In its most general context, metacognition refers to "thinking about thinking." Borrowing Flavell's (1979) words, a more instructional conceptualization of metacognition is "knowledge and cognition about cognitive phenomena" (p. 906). A notable clarification is the distinction between metacognitive knowledge and metacognitive processing. Many researchers have argued that metacognitive knowledge (what one knows about cognition) is distinguished from metacognitive control processes (how one uses that knowledge to regulate cognition) (e.g., Schraw & Moshman, 1995). Metacognitive knowledge consists of three components: declarative, procedural, and conditional (Schraw & Moshman, 1995). Declarative knowledge includes knowledge about oneself as a learner and the factors that influence one's performance. Procedural knowledge refers to knowledge about the execution of procedural skills. Conditional knowledge is knowing when and why to apply various cognitive actions A common thread that weaves these components together is the process of applying and manipulating knowledge components.

Since its initial conceptualization (Flavell, 1979), researchers have further operationalized metacognition as conscious and deliberate processes (thoughts and actions) directed at task engagement (e.g., Borkowski & Muthukrishna, 1992; Carr, Alexander, & Folds-Bennett, 1994; Davidson, Deuser, & Sternberg, 1994). The utilization of metacognitive knowledge comes through self-regulatory processes. Many theorists describe regulatory processes as planning, monitoring, and evaluating (e.g., Scardamalia, Bereiter, & Lamon, 1996; Schraw & Moshman, 1995). Planning involves the selection of strategies and resources that affect performance. Experienced learners possess more knowledge about cognition and use that knowledge to regulate their learning before they undertake a task. Monitoring is one's thoughtful awareness of comprehension and task performance. Monitoring ability develops quite slowly but improves with instruction and practice. Evaluation is the process of appraising the products and regulatory processes of one's learning. Planning and evaluation are closely linked. Regulatory competence is thought to improve performance through efficient use of cognitive resources such as attention, better use of strategies, and enhanced awareness of breakdowns in comprehension (Schraw & Moshman, 1995).

In sum, metacognition refers to higher order thinking that involves knowledge of individual cognitive functioning and active control over one's cognitive processes while engaged in a learning task. Metacognitive processes are sequential, and efficacy is dependent upon utilization of self-regulatory practices. Research over the past two decades has suggested that metacognitive skills can be learned (Clark & Wittrock, 2000). Studies of experts regulating their mental processes when examining and solving problems, and studies of instructional interventions designed to teach metacognition, reveal that metacognitive skills do exist, can be taught, and may be applied to new domains (Borkowski & Muthukrishna, 1992; Pea, 1987).

There is considerable research to support the effectiveness of metacognitive instruction. Borkowski (1989) argued that metacognition helps students understand a strategy's utility, the effort involved, and the benefits of strategy

application. The greater the students' understanding of the strategy, the more likely they are to use the strategy in novel situations. He also suggested that strategy instruction and strategy learning is effortful and requires repeated opportunities to be mastered. When a student learns about strategies over a period of years, they acquire general strategy knowledge and a belief in their own capacity to make a difference in their learning outcomes. Borkowski (1989) identified a good strategy user as someone who knows a large number of learning strategies and understands when, where, and why the strategies are important. In an extensive research synthesis conducted by Swanson (2001) three instructional components were identified as having the strongest impact on student learning. These included (a) control of task difficulty (sequencing problems to ensure challenge and success); (b) teaching exceptional students in small groups (6 or less); and (c) directed response questioning (teaching students to generate questions while solving problems). This final instructional component includes all teaching procedures that promote "thinking aloud" and that have been identified as self-questioning strategies (Wong & Jones, 1982), metacognitive (Brown & Palincsar, 1982), and procedural facilitators (Gersten, Baker, Pugach, Chard, & Scanlon, 2001).

Some of the most salient evidence for the impact of instruction on the metacognition of novice learners stems from research on students with learning disabilities. Overall, current research suggests that compared to nonlearning disabled children, children with learning disabilities experience difficulties in a number cognitive components. Children with learning disabilities are found to experience difficulties in several self-regulatory processes, such as planning, revising, and evaluating during attempts to learn or solve problems (Wong, 1987). Myriad studies have provided convincing evidence that infusing academic instruction with metacognitive components increases learning outcomes students with learning disabilities. These students gain clear advantages when they have received strategy instruction specific to rehearsal, organization, and elaboration. For instance, instructional programs have been developed to improve the writing of elementary school children with learning disabilities (e.g., Englert, Raphael, Anderson, Anthony, & Stevens, 1991) and junior high school students with learning disabilities (e.g., Montague & Leavell, 1994). With respect to reading, interventions that utilize scaffolding strategies have been used to improve leaning disabled children's comprehension ability (e.g., Mariage, 1995). In mathematics, Hutchinson (1993) demonstrated the effectiveness of problem solving strategies for students with learning disabilities.

Research on cognitive functioning (Hacker, Dunlosky & Graesser, 1998; Schraw & Moshman, 1995) supports the notion that metacognition is the master, or executive cognitive process, which coordinates the smooth operation of all other processes and thereby affects all aspects of learning. Moreover, metacognitive instruction can enhance student learning by helping students to become cognizant of their cognitive knowledge and by engaging students in strategies that serve to regulate their metacognitive processing. As teachers have effectively built metacognitive instruction into classroom practice, so too can teachers implement metacognitive instruction to assist students in workplace learning. Indeed, Brown, Bransford, Ferrara, and Campione (1983) stated that if we understand cognitive processes and learning mechanisms involved in a particular domain and recognize developmental differences, then it is possible to teach someone to perform more effectively. The immediate challenge facing the present argument is to transfer ideas about metacognition to workplace learning. Part of this is achieved by the relatively simple step of conceptualizing the workplace as a learning environment. The greater part of the challenge is determining what might function as an appropriate domain or framework. In the next section, we explore the concept of routines to show that it presents a conceptual framework for considering metacognition in workplace learning.

Routines in the Workplace

Resnick (1987) contrasted school learning with learning outside school and identified four broad differences. First, school learning predominantly focuses on individual cognition, whereas most cognitive activity outside school is social. Second, pure thought activity is valued in school and tool use is typically held in disdain, particularly in examination settings, whereas most mental activities outside school involve engagement with tools. Third, school consists mainly of decontextualized symbol manipulation, whereas other settings use the context and objects in them to aid in contextualized reasoning. Finally, schools aim to impart widely usable general skills and theoretical principles with a view to improve transfer to other settings. The ideas about context and general skills are important to our argument. As shown in the review of workplace learning, the idea of generalizable skills seems less than robust for developing classroom instruction about work because workplaces present unique contexts. If we want to enhance workplace learning in the classroom, then we need to look elsewhere. The approach that we take is to

embrace the unique contexts of work and to ask what is common among them. When we do this, we find we cannot escape the idea that routines are central to workplaces. Although routines are manifested quite differently, they are nonetheless routines. Given the obvious success in schools of metacognitive strategy instruction, it seems reasonable to explore the concept of routine to see if it has promise for offering a pedagogical framework for learning in the workplace. In this section, we pursue this argument by reviewing some of the research literature on workplace routines.

Previous studies of students learning in the workplace (Munby, Cunningham, & Chin, 1998; Stasz, MacArthur, Lewis, & Ramsey, 1990) indicate that students learn sequences of tasks that are modeled by their supervisor. Gersick and Hackman (1990) use the label habitual routine. These authors blend Langer's (1989) empirical and conceptual work on "mindful cognitive processing" with Louis and Sutton's (1991) theoretical writing on switching cognitive gears, and with Weiss and Ilgen's (1985) analyses of the antecedents, manifestations, and consequences of habitual behaviour by individuals in organizations. Gersick and Hackman (1990) claim " habitual routines exist when a group repeatedly exhibits a functionally similar pattern of behaviour in a given stimulus situation without explicitly selecting it over alternative ways of behaving" (p. 69). The term "repeatedly" is intended to reflect that a given routine would occur most of the time the stimulus for starting the routine appears. "Functionally similar" means that the routine does not need to look exactly the same but the function the routine serves must be met. The routine also needs to be a "pattern of action" or a sequence of tasks that occur in response to the stimulus and the routine must be recognized as that by individuals who are responsible for that type of work. The "stimulus situation" is the cue to start the routine. There may be more than one stimulus that cues the start of a routine and it may not be clear to an outsider what those cues are. The final aspect of the definition is that the routine is "initiated without selecting it over alternative ways" of doing things. In a sense, it is automatized (Gersick & Hackman, 1990).

Literature suggests that routines assist novice employees and, by association, co-op education students in a number of ways (Cohen & Bacdayan, 1994; Dosi, Nelson, & Winter, 2000; Gersick & Hackman, 1990; Langer, 1997; Louis & Sutton, 1991; Nelson & Winter, 1982; Weiss & Ilgen, 1985). The frequent repetition of routines leads to mastery and acceptance as a legitimate peripheral participant in the community of practice (Lave & Wenger, 1991). Routines also serve to reduce uncertainty and to improve confidence. Novice employees and co-op education students are frequently overwhelmed by the stimuli in a new environment and routines assist in reducing the cognitive engagement needed to complete tasks. This frees cognitive capacity to deal with other effortful tasks in the environment.

Although routines themselves appear to facilitate workplace learning they may also constrain it. As with workplace knowledge, many routines in the workplace are tacit and need to be made explicit for the novice employee or co-op education student. The cues that signal the need to initiate a routine will not be known to those without experience in the workplace setting, and the environmental conditions that trigger the need to alter or stop a routine are also tacit. The cognitive awareness needed to switch to active cognitive engagement may in fact be suppressed by routines the individual engages in. If a workplace novice does not have a good understanding of the environment or the overall organization, it may be difficult for him or her to know when to consider an alternative approach to task completion or when to request assistance (Cohen & Bacdayan, 1994; Dosi, et al., 2000; Gersick & Hackman, 1990; Langer, 1997; Louis & Sutton, 1991; Nelson & Winter, 1982; Weiss & Ilgen, 1985).

Our Empirical Studies of Routines

Examples of routines in widely different workplaces suffuse our case studies of co-op students in their placements (Chin et al., 2000; Munby et al., 1988; 1999; Steiner Bell et al., 2001; Versnel & Munby, 2001). These studies were generally conducted over a semester, and data consisted of observations (initially weekly, then monthly), and formal and informal interviews with the students and with workplace supervisors. In some cases, these interviews were supplemented by interviews with parents or guardians and with high school co-op teachers. Our first case studies were conducted in a veterinary clinic. In this setting, as in others, the researchers faced considerable difficulty in knowing what to observe because the routines in this workplace were foreign to seasoned classroom observers. Early morning routines involved walking animals, cleaning cages, and preparing patients for "routine" surgery, like spays and neuters. These "routine" surgical procedures consisted of routines, beginning with anesthetizing the

patient. And this too was routinized: restraint, shaving the foreleg, inserting the needle, monitoring patient, masking the patient, monitoring the anesthetic machine, and so on.

Our understanding of routines assisted our observations of co-op students in a dental practice. There are routines for welcoming patients, for guiding them to the chair, and for settling them in. There are routines in the preparation of instruments and resins, just as there are routines for cleaning up after each procedure. And when we studied a co-op student on a hospital ward , we saw her divide her time between tasks involving clearing breakfast trays and restocking supplies and tasks in which she interacted more personally with patients: tidying rooms, reading and writing their letters. All these tasks were routines, and each routine had subroutines, even the smallest ones involving greeting patients as she entered their rooms.

As our research team's interest in routines grew, we undertook a series of short (1 to 3 hour) observations of different workplaces and interviews with workplace supervisors to reassure ourselves that the tasks there could be construed as routines, and to discover further characteristics of routines. Sites included a multinational optical lens and frame organization, a large retail multinational department store, a national chain grocery store, and a garden center. Not surprisingly, routines were ubiquitous. In addition to observing the highly context-dependent routines familiar to us in our studies of the veterinary clinic, we were able to identify routines that were common to almost every workplace setting. These routines appeared to be repeated daily and some were enacted several times each day. Many of the workplaces and employees involved in our study had preparatory routines: the sequence of activities involved when the employee first arrives at the workplace. This preparatory routine was highly predictable and repeated daily. Rarely would the employees think of alternative ways of completing the routine. This was the one routine which employees did not have difficulty articulating and it was among the first routines taught to novice employees. The same may be said of closing routines, though in some cases a checklist aided enactment of these sequences.

Another common routine was a customer service routine. This routine took priority over all other routines in every organization we studied, and other routines were to be interrupted when an employee needed to perform a customer service routine. In the large organizations, policies for executing the customer service routine guided the employees in what to do and how to maximize customer service. Finally, we found that most employees and co-op education students were responsible for some basic housekeeping and maintenance routines to ensure the workplace was safe and clean. Sweeping, washing dishes, cleaning toilets or handling garbage were expectations for all employees and co-op education students involved in the settings we studied.

A Metacognitive Theory of Routines

Three central ideas underpin the theory of the metacognitive functions of routines: (a) that work can be conceptualized as routines and (b) that the concept of routines can be taught, and (c) the metacognitive functions of routines gives structure to learning in the workplace. As we have seen above, work can be conceptualized as routines, and routines can be small or large: work tends to comprise routines set within routines. Thus a co-op student's work in restocking hospital linens can be viewed as a routine involving several smaller routines, like identifying different kinds of bedsheets and stacking them appropriately. In the traditional sense, routines are regarded as somewhat unchangeable, but this does not afford a productive way of looking at work because routines in work can be interrupted and can change in response to external or internal conditions. For example, an externally imposed change in the deadline for AERA proposals changes the annual routine of proposal writing for our research team. Equally, a change in the direction of our research may result in a decision to propose for a different conference—an internally directed change in the team's annual routine.

The first step in an instructional theory about routines is to recognize the power of teaching students that they can understand their activities in a workplace in terms of routines. Added power comes from understanding that routines have generalizable properties. For example, the following are characteristic of routines:

> Something initiates them,
> they proceed until some definable point is reached,

and then they repeat.

These are functions of routines. And if we teach students to identify these functions, then we are engaging in metacognitive instruction about the functions of routines. In this case, the instruction is about declarative metacognition, and it invites students to identify the routine(s) for which they have responsibility. Importantly, instruction about these metacognitive functions would be generalizable to all routines because it is about the concept of a routine and not about particular routines that students may or may not encounter in the workplace. So metacognitive instruction here can enhance students' understanding of the work that they are meant to perform, and students would be invited to answer questions like the following as they begin at a work site:

What is the routine? What initiates the routine? How do I know when the routine is complete?

The theory accommodates students who need more context for understanding the routines they perform because it acknowledges that work consists of connected routines. Thus students could be asked to identify the larger routine to which their routine contributes.

The metacognitive instruction described thus far is mostly declarative. It becomes procedural once the students have identified the routine(s) they are to perform and are then asked to identify their activities. At this point, responses to metacognitive questions about routines change from something like, "The bedsheets are sorted" to "I sort the bedsheets."

The conceptualization of routines in the workplace used here embraces the commonplace that routines can fail. As we well know, sometimes routines do not work: they get off track, a component of a routine is omitted, or the initiation is incomplete. Within the workplace, it is clearly important that students learn to identify and then to respond appropriately to this limited range of circumstances in which things can go awry. Thus metacognitive instruction about just a few circumstances covers the range of what students could learn to look for. Here the instruction would be about conditional metacognition. The concept of routines, then, invites students to attend in general terms to what goes wrong, to identify specific failures within their own routines and then to learn within their workplaces how to respond appropriately. Basic metacognitive questions for students to learn to ask themselves might be: "If the routine does not work, is it because there is a problem in the initiation?" and "If the routine does not work, is there a problem in my performance of the routine that allowed it to get off track?"

The theory of the metacognitive functions of routines also accommodates the changeable nature of routines. To a degree, the kind of metacognitive instruction here takes the student to a rather different level because it invites attention to how routines might be improved. Students could be introduced to questions like, "How can the routine be made more efficient? Hw can the routine be combined with another routine into a single routine?" As before, the range of questions one might develop is limited. Importantly, these and other questions suggested above fall from thinking about the concept of routine and not from particular routines. These questions, which together suggest instruction, are independent of particular workplace routines. The general applicability of the questions is a clear strength of instruction that can be built on the metacognitive functions of routines. (Instruction might involve analyzing many examples of workplaces and within them, many examples of routines and subroutines.)

Discussion and Implications

The theory of the metacognitive function of routines for workplace instruction developed in this paper is consistent with our findings about the curriculum of the workplace: "working knowledge" is the mastery of routines, and routines represent the organization of this knowledge (Munby, Chin, & Hutchinson, in press). The metacognitive theory of routines is connected with the literature reviewed in an early section of this paper. That review began with an account of the literature on essential and employability skills, and with the view that such lists were unhelpful for instruction in workplace preparation because the skills are not evidently general in applicability. The metacognitive theory of routines suggests that what is general lies at the level of performance of routines rather than skills themselves, because routines have properties that are generally applicable. The review also considered the

contextual nature of workplace learning. Again, manifestations of routines may be unique from workplace to workplace, but the functions of routines (something initiates them, etc.) are general and are not context-dependent.

The theory shows plainly why workplace knowledge is not just procedural but is at root tacit or opaque (Billett, 1995). Routines are similar to patterns in that they are not self-evident. One almost needs to be looking for regularity in order to observe it. Certainly, the superficial behaviors of workers do not readily reveal the underlying routine that these behaviors are enacting. Billett's (2001) work has shown that the use of guided strategies embedded in everyday work activities has enhanced the development of knowledge needed for successful workplace performance. Billett's recommendations for guided workplace learning at his third level of providing strategies to assist self-monitoring and self-regulation are connected to the theory of routines too: self-monitoring is conceptually part of metacognitive engagement in routines. The metacognitive theory of routines also sits well with the idea of legitimate peripheral participation (Lave & Wenger, 1991). Novices can begin to learn a complex routine by participating in one small subroutine, because participation provides a vantage point for observing and understanding the events that initiate, sustain, and terminate the larger routine. In constructivist terms, this form of participation allows the learner to appropriate workplace knowledge and to make it meaningful (Hung, 1999; Steiner Bell et al., 2001).

That said, the metacognitive theory of routines, as an instructional theory, presents some puzzles for the literature on metacognition. For example, Winne (1995) argued that metacognition might be counterproductive in the early learning of a task. It might be that we need to debate here what constitutes the early learning of a task: we might be tempted to argue that unless the learner has a schema for the routine, which is the task's context, then he or she may be learning the behavior but not the task—the task is not comprehensible without the routine. Other challenges lurk in the literature on routines.

The first of these is the miscoding (Gersick & Hackman, 1990) that occurs when individuals who are engaged in routines have their attention to environmental stimuli reduced. These individuals may not recognize a novel stimulus situation or they may not recognize that the environmental conditions have changed sufficiently to warrant a change in the routine. Another challenge is reduced creativity or innovation. When behavioral repertoires are changeless under conditions in which productive dissent and disagreement are unlikely, then creative or non-traditional ways of responding to tasks do not occur (Gersick & Hackman, 1990). Such circumstances could limit opportunities for growth in competence, in skill, or in perspective: the work gets done but motivation and interest wane. While we recognize that monotony and boredom would interfere with productive workplace learning, we would argue that they challenge *all* theories of workplace learning because monotony is a feature of how work routines are distributed and staffed rather than a function of learning itself.

At present, the metacognitive theory of routines is untested as a foundation for instruction about work. Yet, by highlighting what constitutes mindful engagement in routines, it clearly shows that there are skills that are transferable from one context to another, and that these skills are higher order, metacognitive ones. Because of this, it is tempting to advance some tentative suggestions about the implications of this the metacognitive theory of routines for those involved in co-op education and similar school-to-work programs. For example, co-op education teachers could use the classroom portion of their courses to explain the nature of routines. Equally, workplace supervisors might find it helpful for students to have the overall routines and the subroutines in a workplace identified for them early in their placement, and possibly before they begin to learn tasks. We believe that these approaches can contribute to making the tacit aspects of the routines in the workplace explicit. And the approaches provide a foundation for preparing students to recognize cues for breakdown or indications for changing routines. These implications, though, are premature because we know very little of the contribution that the metacognitive theory of routines can make to workplace instruction.

For our research, the implications of the theory of the metacognitive function of routines are theoretical and instructional. At the theoretical level, we are interested in exploring how our theoretical work on routines leads to a convergence between metacognitive theory about workplace learning and the community-of-practice theoretical work derived from Vygotsky. A connection between the two seems reasonably clear when we suggest that productive coaching about the metacognitive functions of routines would be *metacognitive coaching*. Furthermore, it could be useful to revisit the work of Schön (1983, 1987) from a metacognitive perspective. At the instructional

level, we are committed to investigating ways to enhance workplace learning for students in co-op education and similar school-to-work programs. Issues of access are of special interest. As we know, metacognitive instruction is significantly helpful to students with learning disabilities in school subjects, so we anticipate that the instructional approach implicit in the theory of metacognitive functions will be equally helpful. Our plans are to develop instruction and to assess its efficacy in co-op education and similar school-to-work programs for a range of students including those with learning disabilities.

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